Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

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COVID-19 Rapid Communication

Navigating the challenges of the COVID-19 outbreak: Perspectives from the radiation oncology service in Singapore ☆

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ABSTRACT

In December 2019, pneumonia of unknown cause was reported by China to WHO. The outbreak was found to be caused by a coronavirus which was officially named "severe acute respiratory syndrome coronavirus 2" (SARS-CoV-2), and the disease caused by it was named 'COVID-19'. The first case in Singapore was confirmed on 23rd January 2020. With lessons learnt from the SARS epidemic in 2003 and the H1N1 flu pandemic in 2009, Singapore was much better prepared to deal with the virus outbreak. The government has taken swift measures to contain and break the chain of transmission. Healthcare workers face the challenge of keeping patients and staff safe from the disease. There is a higher risk of mortality of COVID-19 in cancer patients and hence unique considerations for a radiation oncology department operating in an infectious disease outbreak. This article is the recommendations and adapted workflow from the two National Cancer Centres in Singapore with the endorsement by the working committee of the Chapter of Radiation Oncology, Academy of Medicine, Singapore. It highlights the challenges that radiation oncology departments in Singapore face and the appropriate recommended responses. This includes interventions, business continuity plans and workflow in managing a COVID-19 positive patient on radiotherapy.

On 31st December 2019, a pneumonia of unknown cause was reported to the WHO country office in Wuhan. This signaled the beginning of the COVID-19 outbreak. The first case in Singapore was confirmed on 23rd January 2020. This was a 66-year-old Chinese male national from Wuhan. He had arrived in Singapore with his family on 20th January 2020. Within a month, 89 new cases were reported in Singapore. As of 24th March 2020, there have been 509 new cases of COVID-19 cases confirmed in Singapore with 2 deaths and 381,462 cases of COVID-19 diagnosed worldwide with 16,550 deaths in total [1].

With lessons learnt from the 2003 SARS epidemic and 2009 H1N1 flu pandemic, Singapore was much better prepared to deal with the virus [2–4]. The Singapore government responded swiftly. Aggressive contact tracing was initiated for confirmed cases, and close contacts were quarantined for 14 days. A multi-ministry taskforce was also formed on 27th January 2020 with the aim of coordinating national and international responses to the outbreak [5]. The outbreak was then declared a public health emergency of international concern on the 30th January 2020 by the WHO. In Singapore, the risk assessment of the COVID-19 virus from Disease Outbreak Response System Condition (DORSCON) was raised from green to yellow on 23rd January 2020, and from DORSCON yellow to orange on 7th February 2020 (Supplementary Table) [6]. Multiple measures followed as the number of cases continued to increase in Singapore and worldwide. These measures included border restrictions on visitors arriving from Hubei, and on people who had travelled to China in the preceding 14 days. Thermal screening was implemented at immigration, and a 14 days mandatory leave of absence was implemented for Singapore residents returning from China. As the situation continued to escalate in multiple countries, broader border restrictions were placed on new visitors with recent travel history to countries heavily affected

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by COVID-19 [7]. Singaporean residents and long-term pass holders returning from these countries were issued stay-home notices for 14 days upon their return. Individuals who are suspect patients are sent to the National Centre of Infectious Diseases (NCID) for further management.

Challenges of a radiation oncology department

In an infectious disease outbreak, there are additional challenges that are unique to a radiation oncology department and must be considered:

1. Time sensitive nature of oncology treatment. Radiotherapy patients typically require a multi-fraction course of treatment entailing daily visits to the department. Treatments cannot be postponed like elective surgeries without the risk of adverse clinical consequences. For example, in a patient with squamous cell head and neck cancer, 33 fractions of radiation is delivered over 6.5 week. Each week of delay translates to 14% lesser cancer control [8].
2. Radiation Oncology side effects mimicking COVID-19 symptoms. The typical presentation of COVID-19 is nonspecific [9]. Early symptoms may include low grade fever, cough, sore throat, running nose. Many cancer patients on chemotherapy have low grade fever. A sore throat may be due to mucositis from head and neck radiotherapy. Many lung cancer patients may have respiratory symptoms of varying degrees.
3. Unique fractionated nature of radiotherapy. The reduction of clinical workload will take time. Even without taking on new patients, existing patients must finish their course of treatment before workload decreases.
4. Many oncology centres have satellite centres and satellite clinics with reduced capability due to the high cost of linear accelerators. The radiation oncology departments may have to cover satellite centers, with staff working across multiple hospitals. This poses a risk of possible cross infection if a staff becomes infected.
5. Patients with fever should be isolated in a separate room. However, it is not practical to designate a dedicated linear accelerator, CT simulation room for patients at risk.
6. Many patients are seen in the department daily and can be grouped into outpatient follow-ups, on treatment reviews and hospital inpatient referrals. Considerations must be made to minimize contact between different patient groups.
7. Careful manpower planning of doctors, allied health and nurses is required for continued provision of the service, to keep them safe from the disease, and to prevent burn out. Additional staff are also required to help with additional duties, such as temperature screening, triage and contact tracing.
8. Infrastructure considerations within the department for staff physical segregation.

Measures and interventions

From an organizational point of view, oncology is considered a critical service in a tertiary hospital and is expected to continue operations even in an infectious disease outbreak. This is also true from the perspective of the individual patient, who expects his or her oncological treatment not to be disrupted. To ensure such continuity of services, the following measures were implemented.

Patient screening

To minimize risks of infection, a strict visitor policy was implemented. Patients coming for outpatient radiation oncology appointments were limited to one accompanying person at any one time. Children below 12 years of age were not allowed to enter the department. The exception was when the child is the patient. Patients were triaged in a dedicated area and had to fill up a screening questionnaire and have their temperature taken. The questionnaire includes the following:

1. Whether they had fever or cough or shortness of breath.
2. Whether they were in Mainland China (thereafter expanded to include Iran, northern Italy and South Korea in the last 14 days).
3. Whether they had close contact with someone with COVID-19.
4. Patients with respiratory symptoms and a positive contact or travel history would be isolated for further assessment. An infectious diseases specialist would also be consulted if further diagnostic tests or admission was required.

If the patient's symptoms were assessed not to be due to an infectious cause, such as a sore throat from radiation to the neck, the patient would be allowed to proceed with his appointment. Patients who are attending daily radiotherapy treatments will have their temperature taken at triage prior to proceeding to the radiotherapy treatment area. All patients and accompanying persons were issued surgical masks.

Temperature monitoring

As part of the staff illness surveillance system, mandatory twice daily monitoring for all staff working in the department was implemented. The information is updated electronically, and any medical leave is reported daily. The lead of each section (Radiation therapist, Nurses, Radiation oncologist, Physics, Patient service associates) is accountable for surveillance, and must investigate any cluster of 3 or more staff who develop fever or are on medical leave for acute respiratory illnesses.

Patient and staff education

Education materials and information are placed in patient care areas such as the nurses' stations and clinic rooms to educate and remind patients and staff on good personal hygiene, importance of hand washing and the correct way to wear masks.

Ensuring adequate medical supplies

As frontline workers, we must ensure adequate medical supplies for patients coming for treatment, and for healthcare workers in the department. Weekly checks of medical supplies including personal protective equipment such as masks (surgical, N95), gowns, goggles and gloves was implemented.

Ensure continuity of communication channels

As part of an internal communications plan, there must be continuous communication of information from the senior administration to the rest of the radiation oncology team. These included electronic messaging systems, emails and meetings using video or web conferencing. The need for video conferencing to minimize face to face meetings have highlighted the need to plan for and maintain both hardware (including web cams, microphones, speakers) and software (video/web conferencing software) requirements. There is also a need for a fast internet connection.

Manpower considerations

With the evolving COVID-19 outbreak, there needs to be provisions and policies to ensure continuity of radiation oncology services. Senior management needs to plan for adequate manpower should staff fall sick or need to be quarantined as a result of contact

with patients with COVID-19. It is worth noting that the threat of staff catching COVID-19 is more likely to come from social rather than medical interactions. It is important, therefore, that staff exercise social distancing after work hours where possible. Furthermore, the parent institution may redeploy radiotherapy department staff to other sectors helping to manage an outbreak, further depleting already scarce manpower resources. Depending on individual departments, manpower may be augmented by cancellation of conference leave or overseas leave. Having a policy in place will facilitate claims and reimbursements for leave cancellation.

Workload management

Patients already started on radiotherapy treatment cannot have their treatment stopped or postponed without significant clinical consequences. These patients would need to complete their treatment. The focus would be on reducing elective new cases starting radiotherapy. New starts on high maintenance services such as brachytherapy were reduced and alternatives to brachytherapy considered. New cases for specialized services such as stereotactic body radiotherapy and Stereotactic radiosurgery would be reduced. A review of current radiotherapy treatment protocols was undertaken with a view to hypofractionate treatment where possible to reduce treatment time [10]. A review of all outpatient clinic appointments was done, and follow-up appointments were postponed or delayed if deemed appropriate. New cases referred to the radiation oncology department were screened, and all non-urgent cases were postponed.

Business continuity plans

Business continuity is of key importance. There should be provisions within the department such that continuity of radiation oncology services will not be impacted as there is possibility of staff managing confirmed cases and therefore needs to be self-quarantined at home.

1. Physical Segregation of staff across hospitals

Physical segregation of staff was implemented. Movement restrictions were in place such that radiation oncology workers were limited only to one hospital or healthcare campus. Radiation oncologists, physicists and radiation therapists who were working across multiple hospitals were separated across hospitals to maintain no crossover and minimize infection risk.

2. Physical segregation of patients

Physical segregation of patients coming for outpatient visits was important. Outpatients visits are grouped into two categories: Patients coming for follow-up consultations or new patient consultations and patients coming for daily visits for radiotherapy. The patient journey for each category was reviewed. Dedicated patient care areas were relooked, and specific areas were allocated for patient waiting, patient triage, patient consultation.

3. Formation of care teams

Within each hospital/centre, the radiation oncology department was separated into teams (e.g. Teams 1 and 2). This is so that if one team could provide continuity of service should the other team need to be quarantined. Each team lead by a team leader consisted of specialists, non-specialist doctors (trainees, residents, fellows), operations personnel, radiation therapists, patient service associates, nurses, physicists, research staff. Each team would take turns to be the 'clean' and 'dirty' team. The 'dirty team' would be responsible for inpatient consults, assessment of patients with fever, upper respiratory tract infection, pneumonia or suspect COVID-19 patients.

4. Physical segregation of care teams at the workplace

Within the workplace, care teams will have dedicated workspaces. For contact tracing, a close contact was defined as being physically within 2 m for more than 30 min at any time. Within the workplace, the workspace between individuals is at least 2 m apart. Additional rooms or workspaces would be used if required. Within each team, there were separate allocated locations for meals for different groups of staff (physics, nurses, radiation therapists) to prevent mixing. In some large centres, there may be more than one cluster of consultation, planning and treatment rooms. This would serve as an ideal way of physical separation. Where this is not possible in small centres, every effort should be made to temporally segregate staff through shift rotations or staggering of mealtimes to minimize possible cross-contamination. Special attention needs to be given to certain sections of the multidisciplinary teams which are small but essential, for instance physicists. These staff are required to observe strict segregation to ensure that there is no cross-contamination that may bring radiotherapy services to a stop.

5. Remote planning

Some centers have implemented remote planning. The radiation oncologist can remotely dial into the hospital server (with dual security password protection and mobile phone verification) to contour the treatment target volume and organ at risk. The physicist or radiation therapist who is involved in treatment planning can also do so remotely via a laptop at home. This will support staff segregation to ensure two teams working at separate sites.

6. Hygiene and departmental cleaning

As COVID-19 is transmitted by droplets [11], patients and visitors to the center are provided with hand sanitiser at the counter and outside the lifts and along common corridors. Patients with respiratory symptoms are offered a mask. All healthcare professionals on the frontline are to wear surgical masks and gloves when examining patients. Additional personal protective equipment such as an N95 mask, eye protection, and gown is required when attending to a positive or suspect case of COVID-19, or when performing aerosol generating procedures such as insertion of a nasogastric tube or performing a nasoendoscopy. It is also mandatory to wash hands after every single patient contact. High touch areas like the visitor toilets, lifts, escalators, front counter desks, doctors and nurses tables and chairs are cleaned and wiped down several times a day with alcohol based sanitizers. Patient changing rooms are cleaned and the patient linen basket is emptied every hour. The whole area is mopped three times a day with chlorine. Used surgical masks, N95, gowns and gloves and other clinical waste are carefully put into biohazard bags and disposed in a proper manner. Regular safety check is implemented to ensure adherence.

Staff morale

Amid the challenges of the evolving COVID-19 crisis, we must not overlook staff morale. Support for colleagues in the department can be in the form of provision of basic amenities such as thermometers and personal hand sanitisers. Leaders must inspire by leading by example. There must be easily accessible channels for staff feedback and concerns. Constant communication and updates allay fears and clarify misconceptions.

Continuing medical education (CME)

We need to continue to improve and upgrade our professional knowledge to enable us to provide our patients with the best management. CMEs and peer review learning (PRL) are continued by video conferencing between radiotherapy staff working in different hospitals. The Academy of Medicine, Singapore organises CME on COVID-19 management by infectious disease experts to

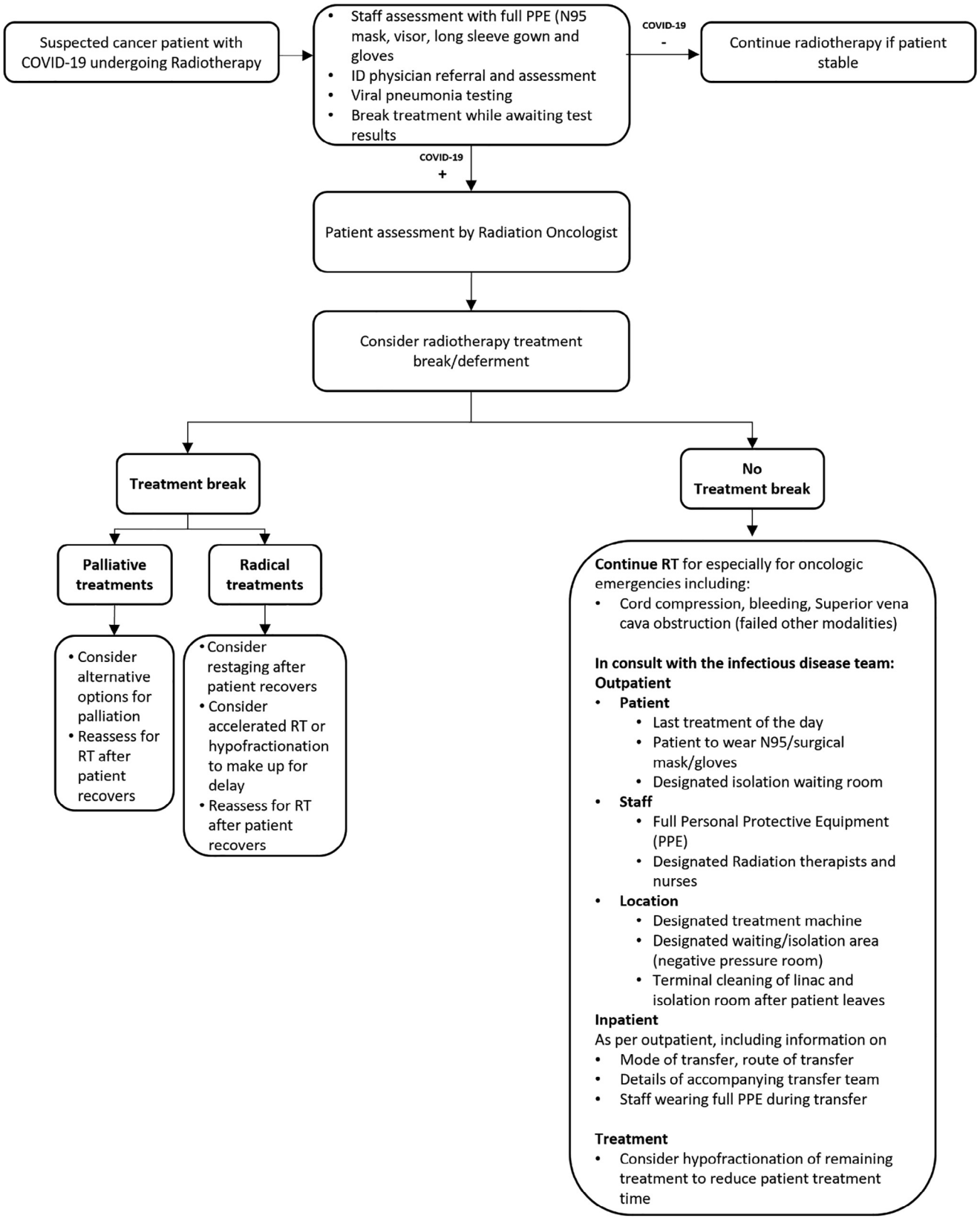

Fig. 1. Workflow for COVID-19 positive patient on Radiotherapy.

Table 1
Summary of Measures for Radiotherapy Departments for COVID-19 (**PREPARE**).

PRoactive in anticipating and planning for the impact of COVID-19
Engage and coordinate with parent institution for policy formation
Prepare for COVID-19 positive patient on radiotherapy
Adequacy of medical supplies
Reduce clinical load
Employ staff segregation

update via video conferencing to ensure all doctors are constantly updated.

Managing a COVID-19 patient who is undergoing radiation therapy (Fig. 1)

With the current ease of contracting COVID-19 and increasing number of cases, it is inevitable that a current patient undergoing radiation treatment may contract the disease halfway through treatment, or just prior to planned treatment. Each department should have a written protocol on the management should the need arise to address this issue.

We recommend:

1. Delaying the start of radiotherapy and stopping ongoing treatment temporarily until the patient is no longer infectious if possible. As the mortality rate of COVID-19 is currently estimated by the WHO to be around 3.4%, it is important to consider a real risk diminished cancer control if radiation treatment is stopped, especially when the radiation is of curative intent. However, if the intent is palliation, other alternative palliative treatments can be explored, and radiation can either be discontinued or resumed only after the patient recovers from COVID-19. Each case should be discussed with the infectious disease specialist to weigh the specific risk and benefits of stopping or proceeding with radiotherapy.
2. When treatment needs to be continued, to consider replanning with a hypofractionated regime in order to complete treatment at the earliest time.
3. To treat the patient as the last case of the day with the staff on full PPE protection. Subsequently, the patient to be transferred back to an isolated room as an inpatient. During treatment, the patient and involved staff will need to don appropriate personal protective equipment (PPE). These may include N95 respirators, surgical masks and gloves depending on institutional policy, available resources and procedural risks. Appropriate high dusting cleaning of the linac room is done on completion of treatment.

Summary of measures for radiation oncology departments in managing COVID-19 (Table 1)

1. Be proactive in anticipating and planning for the impact of COVID-19.
2. Engage and coordinate with the parent institution in formulating policies for identifying patients at risk or who are already infected and contextualizing these to the department during implementation.
3. Reduce clinical load where possible in anticipation of depletion of resources. This may involve temporarily reducing frequency of follow-up appointments, reducing fractionation schedules where possible, and considering alternative treatment modalities apart from radiotherapy that achieves the same therapeutic goals.
4. Employ staff segregation either spatially or temporally to reduce risk of the entire service succumbing to infection or quarantine. Special attention needs to be paid to "bottleneck" personnel (e.g. physicists) where redundancy cannot be built in.
5. Prepare for the possibility of a COVID-19 patient requiring treatment. Plan in advance which indications warrant emergency radiotherapy treatment when proven infectious or merely suspected, what personal protective equipment is required, and how to decontaminate the facility after treatment.

Conclusion

The greatest threat to the sustained delivery of essential radiotherapy service is being overwhelmed by a deluge of covid-19 cases such that the healthcare institution is paralyzed. This can only be mitigated by national and institutional policy. Nonetheless, radiation oncology departments can act to better position themselves to continue radiotherapy services in the face of resource limitations brought on by the outbreak, as well as to protect staff and patients. We must continue to learn and adapt to the constantly evolving COVID-19 outbreak. We hope that other radiation oncology departments worldwide will benefit from our experience in dealing with the COVID-19 threat.

Conflict of interest

No conflict of interest in the submitted work.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.radonc.2020.03.030.

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